CRAWFORD
CONSULTING
INC.

August 10, 2012
Project AE9701

Mr. Saul Bloom
Executive Director
Arc Ecology
1331 Evans Avenue
San Francisco, California 94124

Re: Third-Party Technical Review of RI/FS and Draft ROD for the Hunters Point Shipyard Parcel E-2

Dear Saul:

The findings of my third-party technical review of the Remedial Investigation/Feasibility Study (RI/FS) and Draft Record of Decision (Draft ROD) for the Hunters Point Shipyard Parcel E-2 are presented herein. This third-party technical review was contracted by Arc Ecology and included review of the following documents:

- Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard, San Francisco, California, May 2011
- Radiological Addendum to the Remedial Investigation/Feasibility Study Report for Parcel E-2, Hunters Point Shipyard, San Francisco, California, March 2011
- Draft Record of Decision for Parcel E-2, Hunters Point Naval Shipyard, San Francisco, California, March 2012.

The scope of work also included a tour of Parcel E-2 with Martha Walters of Arc Ecology on May 17, 2012. We were accompanied and briefed by representatives of the Navy and their environmental engineering contractor ERRG.

My review focused on the following areas of expertise:

- Nature and extent of landfill waste
- Nature and extent of contamination in landfill materials, soils, groundwater, surface water, and groundwater
- Geologic and hydrogeologic investigations
- Remedial investigation/remedial action methods and results
- Landfill and waste site closure, monitoring, and postclosure maintenance programs
- Evaluation of remediation alternatives.

Third-party technical reviews focused on the health risk and radiological assessments are being provided by two other technical reviewers contracted by Arc Ecology. We shared and discussed our individual findings and comments during the course of the third-party review process. The conclusions of my review were made with consideration of their comments on the health risk and radiological aspects of the project.

Summary of Findings

1. The data collected through numerous state-of-the practice investigations and interim remedial actions provide sufficient knowledge of the nature and extent of contamination of the E-2 Parcel to support the evaluation and selection of remedial approaches for the site.
2. The remedial approach selected in the RI/FS and draft ROD is considered to be an appropriate approach for site remediation and is consistent with remedial approaches for similar sites.
3. The selected remedy should be capable of providing levels of protection for human health and the environment that meet or exceed regulatory standards.
4. Data gaps have been identified that will need to be addressed with supplemental studies during the final remedial design process for the selected remedial approach but these data gaps do not prevent selection of the overall remedial approach.
5. Capping and containment, using an engineered cap and institutional controls, is the most widely used and accepted practice for landfills of the size and general composition of the Parcel E-2 landfill. The overall plan for capping and containment and the proposed measures to be put in place to protect the ongoing integrity of the cap are generally consistent with industry practice and regulatory requirements. Some specific design elements would require special attention during the final remedial design process and these are noted herein.
6. The capping and containment approach has been used at a number of other bay margin disposal sites in the San Francisco Bay Area, where wastes were originally placed directly on tidal marshlands or Bay Mud sediments and where significant portions of the waste fill are now below the elevation of the shallow water table. These disposal sites include the West Contra Costa Class I Hazardous Waste Management Facility in Richmond, the City of Berkeley Landfill, the City of Alameda Landfill, the Westport Landfill in Redwood City, the Oyster Point Landfill in South San Francisco, the Sierra Point Landfill in Brisbane, the West Winton Landfill in Hayward, the City of Palo Alto Landfill, the Highway 237 Landfill in Alviso, and the City of Mountain View Landfill.
7. Excavation and off-site disposal of the Parcel E-2 landfill, as considered under Alternative 2, would present significant technical and engineering challenges as well as potential health risks during implementation. Excavation and off-site disposal of the landfill under Alternative 2 would present a significantly higher potential risk of exposure of contaminants to site workers, the community, and the environment during implementation than a capping and containment approach. Using the approach described for Alternative 2, it should be technically feasible to excavate and remove most of the landfill materials. However, due to the challenges involved with removing debris and soils from deep excavations in saturated, soft Bay Muds and loose fine-grained sands, it would be very difficult, and possibly not technically feasible, to remove all contaminated debris and soil at and beneath the bottom of the landfill and to be able to reliably demonstrate complete removal. A particular concern would be the ability to drive sheet piles to provide shoring support for the walls of the excavations and limit groundwater infiltration during excavation. Concrete and other landfill debris could obstruct the ability to drive the sheet piles to the required depth for excavation stability.

Specific Comments and Recommendations

1. Stability Analyses to Support Design of Landfill Capping and Containment Systems

The Navy studies have provided assessments of (1) the potential for liquefaction and lateral spreading in native sediments beneath the landfill and (2) static and seismic slope stability for the toe berm of the proposed landfill cover for Alternatives 3 - 5. And the Navy has stated that it specifically plans to perform a quantitative slope stability analysis for the toe berm during the final remedial design process:

> Results of an iterative slope stability analysis determined that a Tensar® UX1500HS or equivalent geogrid with a long-term design tensile strength of 3,100 pounds per foot should be placed under the proposed toe berm, and should extend upslope to an appropriate anchor point within the proposed landfill cap; this conceptual design would meet or exceed design standards prescribed in EPA guidance (EPA, 1995b). This geogrid layer was added under the toe berm proposed for Alternative 3 (Figure 12-4). Because the analyses presented in Appendix Q are a qualitative assessment of the proposed toe berm evaluated in the FS, a quantitative slope stability analysis will be performed as part of the RD. The Navy plans to collect soil samples along the base of the proposed toe berm and to perform shear strength tests (and other appropriate geotechnical analyses) to support the quantitative slope stability analysis in the RD. The proposed sampling and geotechnical analyses would be detailed in a work plan to be reviewed by the regulatory agencies prior to implementation (*Draft ROD, Section 12.2.3.1, Seismic Design of Containment System*).

The Navy has made a general indication, in regard to addressing the potential for liquefaction of soils beneath the landfill, that:

> The Navy will further evaluate, including consulting with other technical experts, this very important part of the design to make sure that the final cover is built to withstand the appropriate design earthquake and comply with numerous other regulatory requirements for landfill covers (*Draft ROD, p. 2-39*).

In the responses to comments in the 2004 Landfill Liquefaction Potential report (Conducted by Tetra Tech EM Inc. for the Navy; presented in Appendix C of the RI/FS), there are indications that the overall stability of the landfill and its containment systems, including the sheet pile wall and groundwater barrier/drain system, would be analyzed in the RI/FS (e.g., "It is recognized that the landfill cover is only one component of the closure system. The Landfill RI/FS report will address each element of the closure system," and "Overall stability of the Landfill will be evaluated by analyzing slope stability analysis. Results of the analysis of slope stability will be presented in the Landfill RI/FS"). Also, the Conclusions section of the report states, "If containment is selected as a remediation measure, response of the Landfill cap, overall stability of the Landfill site, slope stability analysis, and other closure features to prevent lateral movement will be assessed. Results will be presented in the Landfill RI/FS Report."

However, I have not been able to find indications by the Navy in the Draft ROD or RI/FS that the Navy has specifically evaluated to date, or will evaluate in the final remedial design process, as required by California Code of Regulations (CCR) Title 27 for Class III landfills:

1. The engineering properties of the waste materials.

2. The stability of the landfill waste materials and potential displacement or settlement of waste materials within the landfill prism during earthquake shaking.
3. The overall behavior of the landfill and underlying materials during earthquake shaking – the combined effects of potential movement in sediments beneath the landfill and in the landfill materials.
4. A stability analysis of the landfill and its existing and proposed containment systems under both static and dynamic conditions.

In order to be consistent with state-of-the-practice procedures conducted for landfill capping and containment in California, the Navy should commit to addressing the four topics listed above, along with other CCR Title 27 Section 21750(f)(5) requirements for stability analyses, during the final remedial design process.

2. Assessment of Ability to Mitigate Potential Seismic Damage to Landfill Capping and Containment Systems.

The RI/FS and Draft ROD do not adequately assess the potential magnitude or effects of a release of landfill materials caused by failure of the various components of the proposed containment system. As noted above, analyses were performed of the stability and potential movement of subsurface soils, but not of the landfill materials. Comments were made regarding the ability of an engineered cover system to accommodate settlement of subsurface soils[1] and of the potential to prevent failure of the toe berm during liquefaction by incorporating a geogrid layer.[2] However, a scenario addressing potential failure of the cover system due to the overall stability of subsurface soils and landfill materials during seismic shaking was not evaluated.

The ability of a containment approach to successfully prevent exposure of waste materials in the E-2 landfill to the community and the environment is one of the main concerns expressed by the community. The RI/FS and draft ROD indicate that the Navy will do appropriate additional studies and that the design of the cover and other features of the containment system will be addressed during final remedial design. These studies should be performed in conjunction with the stability analyses recommended in the preceding comment and should assess the nature of potential failures to the capping and containment caused by the predicted movement of the subsurface soils and landfill materials. The final cover and other components of the containment system should be designed to withstand the combined effects of liquefaction in subsurface soils and lateral movement and settlement of the overlying landfill materials.

3. Design Earthquake for Final Quantitative Slope Stability Analysis to be Performed

The design earthquake to be used in the final quantitative slope stability analysis to be performed during the final remedial design process should be the Maximum Credible Earthquake (MCE) rather than the Maximum Probable Earthquake (MPE), which was used in the 2004 Landfill Liquefaction Potential study. Use of the MCE for cover design was determined to be "Relevant and appropriate" in the determination of Applicable or Relevant and Appropriate Requirements (ARARs), as stated in the Draft ROD, Attachment 4. (p. 15) and in Section 10.3.1 of the RI/FS.

---

[1] (Conclusions section of the 2004 Landfill Liquefaction Potential report, presented in Appendix C of the RI/FS)
[2] (Conclusions and Recommendations section of the Qualitative Slope Stability Evaluation, presented in Appendix Q of the RI/FS).

The determination for the requirement that "The final cover shall accommodate lateral and vertical shear forces generated by the maximum credible earthquake so that the integrity of the cover is maintained" cited California Code of Regulations, Title 22 §66264.310(a)(5), which is under Division 4.5. Environmental Health Standards for the Management of Hazardous Waste, Chapter 14. Standards for Owners and Operators of Hazardous Waste Transfer, Treatment, Storage, and Disposal Facilities, Article 14. Landfills.

The MCE is the maximum earthquake that appears capable of occurring under the presently known geologic framework whereas the MPE is the maximum earthquake that is likely to occur during a 100 year interval. [Use of the MPE is required for landfill stability analyses and cover design by Title 27 regulations for Class III (nonhazardous) landfills, but this requirement is superseded by the ARAR to use the MCE per Title 22 §66264.310(a)(5), as noted above].

In the response to comments appendix of the 2004 Landfill Liquefaction Potential study, the study cited the Title 27 Class III landfill regulations as the regulatory requirement for using the MPE rather than the MCE. However, the responses also stated that for Parcel E-2, the MCE and the MPE are the same. The responses stated that: "The M7.9 1906 San Francisco earthquake was selected as the MPE. This M7.9 earthquake was the largest historical earthquake recorded," and that "the maximum credible earthquake (MCE) and MPE would yield the same results."

So, while the study indicated that the MPE and the MCE are the same, the final quantitative slope stability analysis to be performed during the final remedial design process should be MCE, not the MPE, in order to address the ARAR determination.

4. Characterization of the Landfill Waste as Primarily Municipal-Type Waste and Construction Debris

The Navy and its consultants have stated the following:

> The Navy installed 28 soil borings and 18 monitoring wells and excavated 25 test pits within the Parcel E-2 Landfill to evaluate the nature and extent of contamination. Based on these investigations, the Navy determined that contiguous solid waste in the Parcel E-2 Landfill is composed primarily of municipal-type waste and construction debris. In addition to municipal-type waste and construction debris, historic information indicates that industrial wastes were also disposed of in or around the Parcel E-2 Landfill, including sandblast waste, radioluminescent devices, asbestos-containing debris, paint sludge, solvents, and waste oils. The characterization data suggest that the quantity of industrial waste within the Parcel E-2 Landfill is less than the quantity of municipal-type waste and construction debris *(Draft ROD, Section 2.3.1. Solid Waste and Soil in the Parcel E-2 Landfill)*.

> Based on data from 26 soil borings, 12 monitoring wells, and 25 test pits extended within the Landfill Area, solid waste in the landfill is primarily municipal-type waste and construction debris. The solid waste includes wood, paper, plastic, metal, glass, asphalt, concrete, and bricks that are mixed with sand, clay, and gravel fill. Historic information indicates that industrial wastes, including sandblast waste, radioluminescent devices, asbestos-containing debris, paint sludge, solvents, and waste oils, were also disposed of in or around the Landfill Area... *(RI/FS, Section 2.1.1. Landfill Area)*.

> The nature and extent of solid waste at the Parcel E-2 Landfill was evaluated based on the physical presence of contiguous industrial or municipal-type wastes. Based on a review of soil borings drilled in the central portion of the landfill from 1988 to 1992, landfill waste consists of wood, paper, plastic, metal, glass, nails, foam, copper wire, cloth, rubber, plywood, ceramics, asphalt, concrete, and bricks, which are mixed with sand, clay, and gravel fill. The waste is usually brown to black. In many areas within the landfill, the waste is mixed with construction debris *(RI/FS, Section 4.2.1. Fill and Solid Waste Characteristics)*.

Direct evidence of deposition of military waste in the E-2 Landfill was also obtained, as discussed below.

> Information on the waste types encountered within the Landfill Area was obtained during remediation activities within the PCB Hot Spot Area, which extended into a small portion the Landfill Area (see Figure 1-3). Out of a total excavation volume of 44,500 cubic yards, 533 cubic yards of soil and fire brick was segregated as radiologically impacted. Also, 40 radiological devices, 78 cubic yards of metal debris, and 19 pieces of other radioactively contaminated debris were identified within the removal area (TtECI, 2007a). In addition, 41 pieces of MPPEH were encountered in the excavation area, consisting primarily of expended cartridge casings of various calibers and protective caps, but also included an empty 5-inch practice projectile and a 3-pound practice bomb (TtECI, 2010) *(RI/FS, Section 4.2.1. Fill and Solid Waste Characteristics)*.

For this review, the descriptions of waste materials encountered in borings and test pits in the E-2 landfill and in other waste disposal areas in Parcel E-2 were compiled (see Attachment A) and reviewed. The descriptions of the waste encountered support the statements and conclusions cited above. As defined by USEPA[3], most of the waste materials described in the logs of the Parcel E-2 borings and test pits can be considered municipal-type waste and construction debris. Municipal waste may include industrial wastes as well as household and commercial wastes.

5. Application of the Presumptive Remedy for CERCLA Landfills

The Navy's proposed remedial measure for the Parcel E-2 Landfill is based on specific criteria established in the USEPA directive "Presumptive Remedy for CERLCA Municipal Landfill Sites," which establishes containment as the presumptive remedy for CERCLA municipal landfills. The USEPA directive, "Application of the CERCLA Municipal Landfill Presumptive Remedy to Military Landfills," clarifies when the application of the containment presumptive remedy is appropriate for landfills found at military installations. Based on my review of these USEPA directives and the rationale presented by the Navy in following these directives, selection of containment as the remedial measure for the Parcel E-2 Landfill is consistent with the USEPA guidance.

6. Biointrusion Deterrence for the Proposed Landfill Cap

To address the question of whether or not the proposed landfill cap design provides adequate deterrence to penetration by burrowing animals, the Navy should provide a summary of the performance to date of the existing geocomposite landfill cap that was constructed in 2000-2001. This performance summary should describe the experience with any burrowing animals and should answer the questions:

[3] http://www.epa.gov/reg3wcmd/solidwastesummary.htm#waste

- Have there been any penetrations of the surface soil by burrowing animals over the last 11 years?
- If so, did any of these burrows penetrate the geocomposite drainage layer, the HDPE membrane liner, or the geosynthetic clay liner?
- If there were penetrations of the geocomposite layer, is there documentation of the repairs made?

If animal burrow penetrations into the vegetative soil layer were observed, but it was not determined whether the geocomposite layers were penetrated, the Navy should investigate those areas and determine if there was damage to the geocomposite layers.

7. Monitoring and Maintenance Program for the Landfill Cap

The final monitoring and maintenance program developed for the landfill cap should be based on experience to date with biointrusion issues, and any other issues noted in the performance. Specifically, the determination of the frequency of landfill cover inspections should consider the interval of time necessary to observe and prevent biointrusion of the geocomposite layers from exposing soil and waste materials beneath these layers.

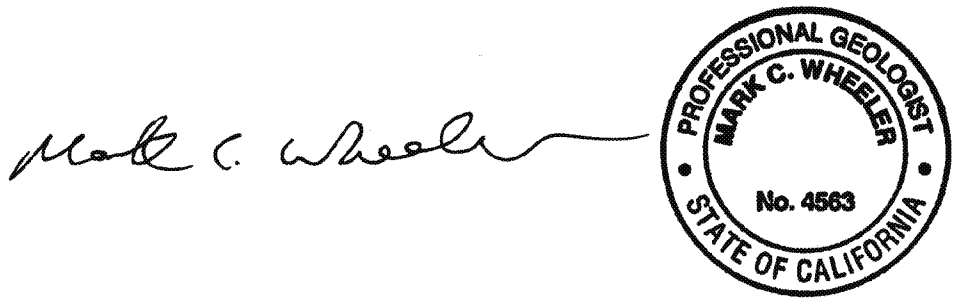
8. On-Going Third Party Review

I recommend that the Navy provide for third-party technical review during the final remedial design process in order to provide the community with assurances that the technical issues are being appropriately addressed and that adequate safeguards to protect public health and the environment are incorporated in the design.

Please call if you have any questions concerning this letter.

Sincerely yours,

CRAWFORD CONSULTING INC.



Mark C. Wheeler, P.G. 4563
Principal Geologist

Attachment Attachment A. Compilation of Landfill Material Descriptions on Logs of Borings and Test Pits for Parcel E-2

Attachment A. Compilation of Landfill Material Descriptions on Logs of Borings and Test Pits for Parcel E-2

ID	Depth	Description
		(Note: all descriptions of materials encountered in waste fill or debris zones are included in this column, without specific depth notations for each entry on log)
Borings		
IR01B001	5.5-28 ft	paper, wire, glass, plastic, wood debris, fibrous material (asbestos?), mixed with sand, silt, and clay
		with treated wood material (creosote?)
IR01B003A	6-15 ft	with wood, steel, and brass
IR01B006	5.5-23 ft	wood, paper and styrofoam, fill
		70% wood and paper debris, 30% serpentinite gravel
		wood, metal, plastic and copper wire
		serpentinite gravel, wood and copper
IR01B011	15-25.25 ft	70% wood, paper, nails, 20% subrounded gravel, 10% coarse-grained sand
		40-60% wood, paper, plastic and copper wire, 20-30% well graded subangular gravel,
IR01B012	12-31 ft	20-30% medium- to coarse-grained sand, fill
		increased coarse-grained sand to 50%
IR01B013	7-25.5 ft	70% wood, wire, rags, metal and plastic
		30% clayey sand and gravel
		50% fine-grained sand, 30% pumice debris, 20% soil
		wood, metal, and plastic logged from cuttings
IR01B018G	9.5-14 ft	70% wood, asphalt, plastic and paper debris
		30% well-graded sand, fill
IR01B019	11-23.5 ft	wood, metal, paper, plastic and glass
		compacted cardboard or other soft object
		70% debris, 30% sandy lean clay
IR01B021	5.5-27 ft	wood, plastic, wire and cloth
		mostly wood debris
		trace glass
IR01B021A	5.5-7.5 ft	wood, plastic and metal wire, oil like product on some wood
IR01B024	6.5-21 ft	wood, paper and plastic
		wood, paper and cardboard debris
		wood, paper, plastic and wash rags
		wood chips, paper, glass, wire, metal cuttings, plastic sheeting, fibrous material and
IR01B025	7-27 ft	gravel
		wood chips, plastic
		wood chips, glass, rubber sheeting and gravel
		50% wood and asphalt debris, 30% fine to medium grained sand, 10% silt, 10%
IR01B029	3-25 ft	gravel fill
		75% debris, 15% sand, 10% silt
		concrete debris
IR01B030	18-25 ft	asphalt and concrete
IR01B036	8-21 ft	95% wood chips, 10% gravel
		50% refuse, glass, plastic sheeting, wood, brick, 50% angular gravel cuttings
IR01B039	12.5-20 ft	50% wood fragments, 5% copper wire, black debris fill
IR01B041	5-9.5 ft	rope
		cloth
IR01B061	4.5-9.5 ft	wood and concrete fragments, some nails, fill
IR01B275	9.5-11 ft	wood, cloth, plastic
	11.5-25.5 ft	wood
		60% wood, glass, and brick debris, 20-30% well graded gravel, 10-20% fine to coarse
IR01B364	3.5-5 ft	grained sand, fill
IR01MW02B	5-19.5 ft	wood, cloth, asbestos, plastic, little well graded sand and gravel, fill
		mostly wood, trace cloth, rubber and metal
		mostly wood, steel, brass, glass, plastic, asbestos, cloth, 20% well graded sand and
IR01MW03A	5.5-23 ft	poorly graded gravel, fill

Attachment A. Compilation of Landfill Material Descriptions on Logs of Borings and Test Pits for Parcel E-2

ID	Depth	Description
		(Note: all descriptions of materials encountered in waste fill or debris zones are included in this column, without specific depth notations for each entry on log)
IR01MW05A	7-26.5 ft	cardboard, asphalt, nails, plastic and glass debris, 30% silt and clay
		fiberglass, paper, wood, glass, plastic and cloth debris
		wood debris
IR01MW16A	5.5-22.5 ft	asphalt and wood debris
		wood, metal and cardboard
		wood and nails
IR01MW17B	3-19 ft	some wood debris, tace paper and plastic debris, 20% gravel and lean clay, fill
		some wood, plastic sheeting, foam rubber, rubber, and leather
		mostly wood with glass, cardboard, plastic and metal debris
IR01MW18A	6-18 ft	paper, plastic and wood debris
		wood, plastic, paper, metal, glass and slag debris with 50% very dark gray silty sand
IR01MW26B	7-24 ft	wood, metal, concrete, cloth and plastic
IR01MW38A	5-10 ft	wood and metal debris
IR01MW53B	10-12.5 ft	concrete, wood, and metal debris
IR01MW1-5	5-22 ft	35% refuse, cloth, fill, 60% fine to medium sand, 5-12% low plasticity fines
		refuse, wood fragments, fibrous material
		85-95% refuse, plastic, wood and copper wire
		15-20% refuse, plastic, wood, occasional blue sandy pockets
		65% refuse, wood
		85-90% refuse
		50% refuse
IR01P03AA	8.5-27.5 ft	composed mostly of wood
		mostly wood and paper products
		95% wood, 10% paper, 5% plastic
		debris consisting of glass, newspaper, wood
IR01P03AB	8-26.5 ft	10% concrete
		50% plastic, glass
		wood and lumber debris with creosote odor
		wood debris with creosote odor, 50% poorly graded gravel
		65% wood, nails, wire, rags, plastic, paper, 20% lean clay, 10% coarse grained sand,
IR12MW17A	2-16.5 ft	5% coarse gravel, fill
Test Pits/Trenches		
TPBWE08B	4-22 ft	rubber, brick, metal, plastic, paper, tile and wood, 40% gravel
TPBWE14	9.5-15.5 ft	wood, plastic, cloth, and metal debris, with coarse black sand
WE01	1-2 ft	trash, bluish gray soil
WE02B	1-2 ft	10% trash, gravel backfill
WE03B	2-12 ft	10% debris, gravel backfill, hard gravel
		wood debris, large asphalt concrete
		5 % debris, 40% gravel
		10% debris, 40% gravel
WE04B	0-4 ft	gravel, wood, paper, and metal debris, clay backfill
		80-90% debris
WE05B	2-13 ft	wood debris
		wood debris, silty clay
		10% debris, sand soil, 50% gravel
WE06A	4 ft	wood, gravel debris, 30% gravel fill
WE06B	0-3 ft	30% trash, gravel backfill
		30% trash
WE07B	0-5 ft	30% wood and metal debris, silty clay
		more wood debris
WE08	2-4 ft	brick, paper, concrete rubble, 20% concrete rubble in soil

Attachment A. Compilation of Landfill Material Descriptions on Logs of Borings and Test Pits for Parcel E-2

ID	Depth	Description
		(Note: all descriptions of materials encountered in waste fill or debris zones are included in this column, without specific depth notations for each entry on log)
WE09	0-9 ft	bricks, 50% concrete rubble, silty sand fill material
WE17B	4-16 ft	5-10% wood debris
		brick, gravel, large debris in clean fill
		small metal debris, wood debris
WE17C	14-16 ft	small pieces of metal scraps
		wood debris
WE17E	4-10 ft	10% small wood debris and asphalt, large gravel fill
		30% metal debris
		50% wood debris and concrete blocks
WE18A	4-12 ft	5% brick debris, clayey sand
		5% wood and metal debris (also plastic and rags), 20% gravel, remaining is black soil
WE18B	0-13 ft	metal, 10% plastic bricks, silty clay with 30% gravel
		70% debris (wood, tire, metal, plastic)
WE18C	0-6 ft	45% debris (wood, plastic, brick), 30% gravel
		debris (wood, paper, glass)
WE19A	12-16 ft	5% wood debris
		60% debris (wood, brick, gravel, plastic), soil, clay
WE19B	8-10 ft	30% wood debris
		95% wood debris
WE20A	6 ft	90% debris (wood, plastic, brick), clayey soils
WE21A	1 ft	40% debris (PVC pipes, large concrete)